DOCUMENT RESUME

ED 223 194 IR 010 445

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TITLE An Exploratory Study of the Relative Effectiveness of Realistic and Non-Realistic Color in Visual Instructional Materials.
PUB DATE May 82
NOTE 7p.; Paper presented at the Annual Meeting of the Association for Educational Communications and Technology, Research and Theory Division (Dallas, TX, May 1982). For other papers, see IR 010 442-487.
PUB TYPE Information Analyses (070) -- Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Audiotape Recordings; College Students; Cues; Higher Education; Instructional Materials; Intermode Differences; Media Research; *Realism; *Slides; *Visual Learning; *Visual Stimuli
IDENTIFIERS *AECT Research and Theory Division Meeting; *Color Stimuli; Stimulus Complexity; Visual Representation

ABSTRACT

In order to compare the instructional effectiveness of realistic and non-realistic color cueing on visualized instruction, an instructional unit on the human heart, using slides and an audiotape, was presented to 244 college students. Four treatment groups received the same oral presentation, with the addition of different types of visual illustration--black and white shaded drawings, realistic color drawings, or non-realistic color drawings--for the three remaining groups. Both immediate acquisition and delayed retention effects were examined. The realistic color group was found significantly superior to the non-illustrated group. Results showed that different materials were not equally effective in facilitating achievement. Although the relative number of visual cues, or visual complexity, was held constant across color treatment, achievement differences favored the realistic color group. Facilitative effects of visual materials on learning disappeared after 6 weeks. An eight-item bibliography is provided. (LMM)

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IR010445

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AN EXPLORATORY STUDY OF THE RELATIVE EFFECTIVENESS OF REALISTIC AND NON-REALISTIC COLOR IN VISUAL INSTRUCTIONAL MATERIALS

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PROBLEM STATEMENT

The primary purpose of this study was to compare the relative instructional effectiveness of two forms of color cueing in visualized instruction. Immediate acquisition as well as delayed retention effects were examined. The specific research question on which the study was focused was:

> When visual complexity, in terms of color cues, is held constant, does the degree of realism significantly affect the instructional effectiveness of visuals?

RELATED LITERATURE

Two major theoretical orientations deal with the question of realism and complexity in learning from visual materials.

The first, a group of theories collectively referred to as "realism theories" by Dwyer (1967) include the iconicity theory of Morris (1946), Dale's (1946) cone of experience and the surrogate fidelity theory of Gibson (1954). All of these theories are predicated on the assumption that the more realistic an instructional device, the more effectively it will facilitate learning. This assumption is based on the notion that the more realistic materials will present more visual cues to the learner and thus, give him more information with which to work. Justification is provided by the basic theory of stimulus generalization and the concept of cue summation.

A conflicting orientation suggests that the "realism theories" do not accurately describe how visual instructional materials function in learning, and in fact, may be in direct contradiction to the true situation.

Broadbent (1958, 1965) has described the human information processing system as a single-channel, limited capacity system. This system functions much like a filter in that, in times of high information reception, not all information perceived is immediately processed and stored. Rather, the system filters out all information beyond its capacity and holds this "overflow" for later processing. The overflow may possibly block other incoming, relevant information. Jacobson (1950, 1951) further supported this contention and indicated that only a small percentage of all information perceived is effectively stored and utilized by the nervous system.

Working from the theory of Broadbent, Travers (1964) focused specifically on the question of realism in instructional materials. He suggested that, to deal with a complex environment, the nervous system must simplify inputs and perceptions. To achieve this end, Travers described a process known as "compression." In describing this phenomenon, he indicated that to maximize the instructional

effectiveness of visuals, it may be necessary to discard some elements of a visual which contain little information. This position is supported by empirical research conducted by Cherry (1953), Attneave (1954), and Dwyer (1972).

The studies reported by Dwyer represent the single, most comprehensive group of studies in this area. He found strong evidence to indicate that the most realistic visuals are not necessarily the most effective in promoting student learning. The relevance of visual realism to the use of color is readily apparent. Color in a great many visual illustrations can represent a significant contribution to the realism depicted in those visuals.

Research related specifically to the use of color has, similarly, been inconclusive. In a number of studies investigating the use of color in instructional visuals (VanderMeer, 1952; Kanner and Rosenstein, 1960; and Katzman and Nyenhuis, 1972) it was generally concluded that color has no significant effect on learner achievement.

Other studies, however, have reported conflicting data. Color was found to be a significant design factor in research conducted by Bourne and Restle (1959), Saltz (1963), Underwood (1963), and Dwyer (1972).

The distinction between visual complexity and realism is, however, an important one when color is considered. Complexity in visual displays may merely imply an increase in the total number of available cues. Realism, on the other hand, implies that real-life associations with information already held in memory store are elicited by the realistic stimulus.

Relative to the increased effectiveness of color, two explanations appear possible. First, color may provide an additional dimension of realism which results in the learner attaining a more complete or realistic image of the event or object; second, color may function only as a coding or cueing device which facilitates storage and retrieval of the image or information. If the former alternative is true, then a realistic color visual should facilitate retention of material to a greater degree than a non-realistically colored visual. If the latter alternative is true, then all types of color visuals should function equally well in facilitating retention of material.

A problem overlooked in the literature deals with the task of designing equivalent materials to test the color hypothesis. The very nature of the color visual militates against attainment of equivalence. Specifically, the use of color in a visual adds a much greater number of visual cues to the display, resulting in a greater amount of available information as well as an increase in processing time.

STIMULUS MATERIALS

The materials employed in this study consisted of an instructional unit on the human heart, developed by Dwyer (1967), and presented by means of slides and audio tape. Each program contained a series of visuals intended to complement the same oral script. Two sets of visuals were prepared in realistic color and two sets were produced in non-realistic color by means of photographic reversal. The remaining two sets were prepared in black and white and non-illustrated formats, respectively.

Photographic reversal was used as a means of producing visual materials in which the total number of visual cues were held constant while the degree of realism (color-realistic or non-realistic) could be manipulated.

Measurement of achievement was accomplished by the use of five tests developed by Dwyer for the evaluation of student achievement in the areas of drawing, identification, terminology, comprehension and total understanding.

PROCEDURE

The data for this study were obtained from 224 college students enrolled in the Instructional Media 411 course at the Pennsylvania State University.

During orientation sessions to the course, all S's were requested to complete two pretest instruments, the Otis Mental Ability Test (Form FM) and a general pretest in the content area.

Subjects were randomly assigned to one of six treatment groups. These treatment groups received the same oral presentation; however, each of the six groups received their own respective type of visual illustration. These groups represented (1) verbal/non-illustrated; (2) black and white shaded drawings; (3 and 5) realistic color drawings; (4 and 6) non-realistic color drawings.

Immediately after participating in their respective instructional treatment, S's were administered the battery of achievement tests. Six weeks later students met again for the delayed posttest battery.

STATISTICAL ANALYSIS

A one-way analysis of covariance was selected as a means of analyzing the data. Pearson Product Moment Correlations were conducted between each of the immediate and delayed acievement posttests and the two pretest measures. In all instances, the Pearson r correlation coefficient was significantly different from zero at the .01 level. Accordingly, these two pretest measures were selected for use as adjusting variables in the analysis of covariance.

In those cases where a significant F-ratio at the .05 level was indicated by the analysis of covariance, further analyses were conducted between all possible pairs of adjusted means via Tukey's WSD Test.

RESULTS

The analysis of the immediate test scores via analysis of covariance produced the following F-ratios: Drawing (2.94), Identification (3.01), Terminology (3.02), Comprehension (0.35) and Total Test (3.15). Four of these F-ratios (Drawing Test, Identification Test, Terminology Test and Total Test) were significant at the $p < .05$ level.

Multiple comparisons between adjusted means were made in each instance where a significant F-ratio was obtained. In every case, Group V (realistic color) was found to be significantly superior to Group I (non-illustrated group) at the $p < .05$ level.

Analysis of the data obtained from the six treatment groups on the five delayed (6 weeks) posttests produced the following F-ratios: Drawing Test (0.91), Identification Test (0.82), Terminology Test (0.26), Comprehension Test (0.92) and Total Test (1.07). All of these values were non-significant at the .05 level of significance.

A summary of those presentations most effective in facilitating learner achievement on each test is presented in Table I.

Table I: Treatments Most Effective in Facilitating Achievement on Each Achievement Test as Compared with the Non-Illustrated Treatment.

Achievement Test	Immediate Posttest	Delayed Posttest
Drawing Test	Realistic Color Presentation	-
Identification Test	Realistic Color Presentation	-
Terminology Test	Realistic Color Presentation	-
Comprehension Test	-	-
Total Test	Realistic Color Presentation	-

DISCUSSION

A number of conclusions can be drawn from the analyses obtained in this study.

1. Different visual materials incorporating different degrees of visual complexity or different types of cueing devices are not equally effective in facilitating student achievement relative to different instructional objectives.

2. The data suggest that in those cases where visual materials were significantly more effective than instruction without visuals, realistic color cued visuals were most effective in facilitating student achievement.

3. The data further indicated, in those cases where color visual instructional materials were superior to verbal materials, that realistic color materials were more effective than non-realistic color materials. Since the overall number of visual cues presented in any corresponding pair of color visuals (realistic and non-realistic) were the same, it must be concluded that the increased effectiveness of the realistic color materials was due to the factor of realism rather than increased visual complexity.

   This conclusion does not, however, support the principle of cue summation. Cue summation suggests that merely increasing the number of available cues would improve achievement. In this study, the relative number of visual cues was held constant across each color treatment, yet differences in achievement in favor of the realistic color group were observed.

   It can generally be concluded, therefore, that the concept of realism is, to a limited degree, an important factor for consideration in the design of visual instructional materials. It can further be concluded that realism in a visual display is a factor which should be considered in addition to the total number of visual cues presented. In terms of the design of instructional materials, this would mean that teachers and designers should avoid the use of non-realistic colors or shadings in visuals unless they serve a specific purpose, such as to make parts or objects more distinct from one another or from a background.

4. Evidence further suggests that while visual materials used to complement instruction facilitate immediate retention of information, these effects disappear after six weeks.

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